STRATEGY FOR RECOVERY

Recovery of bull trout will require reducing threats to the long-term persistence of self-sustaining, complex interacting populations of bull trout across the species' native range, and preserving the diversity of bull trout life-history strategies (*e.g.*, resident or migratory forms, emigration age, spawning frequency, local habitat adaptations). Migratory fish allow genetic exchange between populations and colonization of unoccupied habitats.

The main threats to bull trout persistence are habitat fragmentation and degradation, passage barriers that isolate populations, competition and predation from nonnative fishes, angling mortality, and effects resulting from isolation and small population sizes. The recovery strategy is to restore habitats and connectivity, reduce effects of nonnative fishes, and reduce angling mortality (Table 2) . Restoring bull trout habitats will require identifying habitats for all bull trout life history stages; identifying site-specific threats (*e.g.*, unsuitable water quality and habitat conditions); and protecting, restoring, and maintaining suitable watershed, riparian area, and stream channel habitats. Restoring connectivity will require identifying and correcting passage barriers, where appropriate (*e.g.*, where restoring passage would not encourage invasion of nonnative species). Restoring habitats and providing passage will also provide opportunities for genetic exchange among local populations and expand the resources available to bull trout.

Development of standardized guidance for monitoring and assessment of bull trout populations is an important component of the recovery strategy. Accurate assessment of population trends, distribution, and response to recovery actions is essential for evaluating recovery implementation. For instance, the recovery criterion - "stable or increasing trends for adult bull trout abundance" requires estimating the magnitude and direction of the population trend. Estimates made for current conditions can be compared to estimates made at some future time to evaluate whether implemented actions have contributed to recovery and can also help identify which recovery units or core areas require the most protection, or most urgent action.

Table 2. Relationship of Recovery Actions and Criteria to Threats and Listing Factors to Bull Trout Recovery Planning.

LISTING FACTOR	THREAT	RECOVERY CRITERIA*	RECOVERY ACTIONS
A	Dams	1,2,,3,4	1.2 barriers, 1.4dam operation, 5.1monitor recovery efforts, 5.2research BT abundance, habitat & tasks, 5.5improve info on distribution & status, 7.1-3assess implementation by recovery units & revise plans
A	Forest Management Practices	1,2,,3	1.1water quality, 1.3 restore stream & riparian, 5.1monitor recovery efforts, 5.2research BT abundance, habitat & tasks, 5.3evaluate BMP's for habitat, 6.1use partnerships to protect & restore core area functions, 7.1-3assess implementation by recovery units & revise plans
A	Livestock Grazing	1,2,,3	1.1water quality 1.3 restore stream & riparian, 5.1monitor recovery efforts, 5.2research BT abundance, habitat & tasks, 5.3evaluate BMP's for habitat, 6.1use partnerships to protect & restore core area functions, 7.1-3assess implementation by recovery units & revise plans
A	Agricultural Practices	1,2,,3,4	1.1water quality 1.2 barriers 1.3 restore stream & riparian, 5.1monitor recovery efforts, 5.2research BT abundance, habitat & tasks, 5.3evaluate BMP's for habitat, 6.1use partnerships to protect & restore core area functions, 7.1-3assess implementation by recovery units & revise plans
A	Road Construction and Maintenance	1,2,,3,4	1.1water quality 1.2 barriers, 5.1monitor recovery efforts, 5.2research BT abundance, habitat & tasks, 5.3evaluate BMP's for habitat, 6.1use partnerships to protect & restore core area functions, 7.1-3assess implementation by recovery units & revise plans
A	Mining	1,2,,3,4	1.1water quality 1.3 restore stream & riparian, 5.1monitor recovery efforts, 5.2research BT abundance, habitat & tasks, 5.3evaluate BMP's for habitat, 6.1use partnerships to protect & restore core area functions, 7.1-3assess implementation by recovery units & revise plans

LISTING FACTOR	THREAT	RECOVERY CRITERIA*	RECOVERY ACTIONS
A	Residential Development	1,2,,3,4	1.1water quality 1.2 barriers 1.3 restore stream & riparian, 5.2research BT abundance, habitat & tasks, 5.3evaluate BMP's for habitat, 6.1use partnerships to protect & restore core area functions, 7.1-3assess implementation by recovery units & revise plans
B	Illegal and incidental harvest	1,2,,3	3.1fish mngmt. plans, 3.2evaluate angling, 3.3evaluate fisheries effects 3.4evaluate sport fishing reg.s, 5.1monitor recovery efforts, 7.1-3assess implementation by recovery units & revise plans
C	Interspecific interactions, including predation where non-native salmonids are introduced	1,2,,3	2.1 fish stocking, 2.2 illegal transport, 2.3educate about illegal intro., 2.4effects of non-native control, 2.5control non-native, 2.6tasks to reduce effects, 3.3evaluate fisheries effects, 5.1monitor recovery efforts, 6.1use partnerships to protect & restore core area functions, 7.1-3assess implementation by recovery units & revise plans
C	Disease(not currently a threat, but will be monitored)		5.4evaulate effects of disease & parasites & minimize effects
D	The Inadequacy of Existing Regulatory Mechanisms	1,2,,3,4	1.1water quality 2.1 fish stocking, 2.2 illegal transport, 2.5control non-native, 3.1fish mngmt. plans, 3.2evaluate angling, 3.4evaluate sport fishing reg.s, 4.1incoporate genetic conservation, 4.3genetic plans for transplantation & propagation, 5.1monitor recovery efforts, 5.3evaluate BMP's for habitat, 5.5improve info on distribution & status, 6.1use partnerships to protect & restore core area functions, 6.2use Federal authorities for BT, 6.3enforce reg.'s & evaluate, 7.1-3assess implementation by recovery units & revise plans
E	Introduced Non-native species	1,2,,3	2.1 fish stocking, 2.2 illegal transport, 2.3educate about illegal intro., 2.4effects of non-native control, 2.5control non-native, 2.6tasks to reduce effects, 3.3evaluate fisheries effects, 5.1monitor recovery efforts, 7.1-3assess implementation by recovery units & revise plans

LISTING FACTOR	THREAT	RECOVERY CRITERIA*	RECOVERY ACTIONS
E	Isolation and Habitat Fragmentation	1,2,,3,4	1.2 barriers, 1.4dam operation, 4.2mainatin gene flow, 4.3genetic plans for transplantation & propagation, 5.1monitor recovery efforts, 5.2research BT abundance, habitat & tasks, 5.3evaluate BMP's for habitat, 5.5improve info on distribution & status, 5.6improve understanding of genetics & local populations, 6.1use partnerships to protect & restore core area functions, 7.1-3assess implementation by recovery units & revise plans

Listing Factors:
A. The Present or Threatened Destruction, Modification, or Curtailment Of Bull Trout Habitat or Range
B. Overutilization for Commercial, Recreational, Scientific, Educational Purposes
C. Disease or Predation (disease not a major factor)
D. The Inadequacy of Existing Regulatory Mechanisms
E. Other Natural or Manmade Factors Affecting Its Continued Existence
Recovery Criteria ***** *All recovery units meet their criteria, as identified in the recovery unit chapters.*
1. The distribution of bull trout in identified and potential local populations in all core areas within the recovery unit
2.The estimated abundance of adult bull trout within core areas in the recovery unit, expressed as either a point estimate or a range of individuals
3. The presence if stable or increasing trends for bull trout abundance in the recovery unit
4. The restoration of passage at specific barriers identified as inhibiting recovery.
Tasks - General (see plan for details)
1 - Protect, restore, and maintain suitable habitat conditions for bull trout
2 - Prevent and reduce negative effects of non-native fishes and other non-native taxa on bull trout
3 - Establish fisheries management goals and objectives compatible with bull trout recovery, and implement practices to achieve goals.
4 - Characterize, conserve, and monitor genetic diversity and gene flow among local populations of bull ttrout.
5 - Conduct research and monitoring to implement and evaluate bull trout activities, consistent with an adaptive management approach using feedback from implemented site-specific recovery tasks.
6 - Use all available conservation programs and regulations to protect and conserve bull trout and bull trout habitats.
7 - Assess the implementation of bull trout recovery by recovery units, and revise recovery unit plans based on evaluations.

Research is also an important component of the recovery strategy. Conducting research on the biological and habitat responses to recovery actions will improve on-the-ground application of future actions through adaptive management. Research will also be necessary to develop monitoring programs.

Ultimately, bull trout recovery is dependent upon using cooperative partnerships and interagency collaboration. Because most bull trout habitats occur on federally-managed lands, more opportunities and responsibilities to conserve bull trout under the Endangered Species Act occur on these lands compared to those under other ownerships. The U.S. Fish and Wildlife Service developed land management guidance (USFWS 1998c) promoting bull trout conservation to assist in consultations while this draft recovery plan was being developed. The U.S. Fish and Wildlife Service recommends consideration of the guidance, as well as the management direction and intent contained in PACFISH, INFISH, Northwest Forest Plan, and additional conservation provisions (summarized in Appendix 3), by Federal agencies when planning and implementing activities affecting bull trout and bull trout habitats.

Habitat and Population Terminology

Various terms to describe bull trout habitat and population units have been used in the literature, agency reports, and documents for ongoing conservation efforts. In many instances there is considerable overlap and ambiguity in the terminology. To ensure consistency throughout the recovery plan and define the scope of recovery, we developed standardized terminology for bull trout habitat and population units. Terms for population units are hierarchical, allowing recovery efforts to be focused at various spatial scales.

Local populations: Groups of bull trout that spawn in various tributaries are generally characterized by relatively small amounts of genetic diversity within a tributary but high levels of genetic divergence between tributaries (Leary *et al.* 1993; Taylor *et al.* 1999; Spruell *et al.* 2000). This suggests that many bull trout have a high fidelity (attachment) to specific streams (Kanda and Allendorf 2001) and can be characterized as local populations. The results of many studies support the hypothesis that many streams support local populations that are isolated reproductively (Kanda *et al.* 1997; Kanda 1998; Spruell *et al.* 1999; Kanda and Allendorf 2001; Neraas and Spruell 2001). As noted by Spruell *et al.* (1999), these widespread patterns of genetic variation most likely reflect historical population structures, past evolutionary events, and the general life history of bull trout.

Core Areas: The recovery plan considers local populations of bull trout to be partially isolated, but have some degree of gene flow among them. Such groups

meet the definition of (Meffe and Carrol 1994) and function as (Dunham and Rieman 1999) a metapopulation. The intent of the recovery plan is to have core areas reflect the metapopulation structure of bull trout. Within a bull trout metapopulation, local populations are expected to function as one demographic unit (Hanski and Gilpin 1997). All local populations within a bull trout metapopulation would be at a common risk of extinction and have a relatively high degree of genetic relatedness (Kanda and Allendorf 2001). In theory, bull trout metapopulations can be composed of two or more local populations. However, Rieman and Allendorf (2001) have suggested that between 5 and 10 local populations are necessary for a bull trout metapopulation to function effectively.

Recovery Units: Bull trout may be grouped so that they share genetic characteristics as well as management jurisdictions (See Dunham and Rieman 1999; Rieman and Allendorf 2001). Such groups have been classified as recovery units. They can range from one local population to multiple core areas. The recovery units identified in this plan are the units at which recovery efforts are specified and evaluated. As such, it was important to consider the genetic relationships between populations as well as how populations should be grouped to foster effective management. For example, most recovery units do not cross state boundaries nor do they include mainstem areas of the Snake or Columbia rivers. This grouping was designed to promote local management decisions concerning populations of bull trout that are demographically dependent. In addition, most recovery units are composed of multiple core areas and single or multiple recovery units compose a distinct population segment.

There are 27 bull trout recovery units (Table 1) in the coterminous United States (1 for the Klamath River, 22 for the Columbia River, 1 for the Jarbidge River, 2 for the Coastal-Puget Sound, and 1 for the St. Mary-Belly River distinct population segments).

For the purposes of bull trout recovery planning, abundance levels were conservatively evaluated at the local population and core area levels. Local populations that contained fewer than 100 spawning adults per year were classified at risk from inbreeding depression. Bull trout core areas that contained fewer than 1,000 spawning adults per year were classified as at risk from genetic drift. Further details and guidelines regarding these minimum population sizes are provided in the recovery plans for each recovery unit. In some instances these guidelines depart from the theoretical and reflect the judgment of the recovery unit teams based on current habitat limitations, appraisals of prospects for developing and achieving recovery criteria, and best available information.

Recovery Goals and Objectives

The goal of the bull trout recovery plan is to **ensure the long-term persistence of self-sustaining, complex interacting groups of bull trout distributed across the species native range so that the species can be delisted**. Recovery of bull trout will require reducing threats to the long-term persistence of populations, maintaining multiple interconnected populations of bull trout across the diverse habitats of their native range, and preserving the diversity of bull trout life-history strategies (*e.g.*, resident or migratory forms, emigration age, spawning frequency, local habitat adaptations). To accomplish this goal, the following four objectives have been identified:

- Maintain current distribution of bull trout within core areas as described in recovery unit chapters and restore distribution where recommended in recovery unit chapters.

- Maintain stable or increasing trends in abundance of bull trout. Abundance levels will be defined in individual recovery units.

- Restore and maintain suitable habitat conditions for all bull trout life history stages and strategies.

- Conserve genetic diversity and provide opportunity for genetic exchange.

Actions and tasks described in the recovery plan address these objectives, or generate information useful in refining and evaluating them.

Recovery Criteria

Recovery criteria for bull trout address quantitative measurements of bull trout distribution, population characteristics, and threats that are linked to recovery objectives. Recovery criteria are developed on a recovery unit basis. Criteria specific to each recovery unit are presented in each recovery unit chapter. Individual chapters may contain criteria for assessing the status of bull trout and alleviating threats that are unique to one or several recovery units. However, every chapter will contain criteria addressing the following characteristics:

- The distribution of bull trout in identified and potential local populations in all core areas within the recovery unit;

- The estimated abundance of adult bull trout within core areas in the recovery unit, expressed as either a point estimate or a range of individuals;

- The presence of stable or increasing trends for adult bull trout abundance in the recovery unit; and

- The restoration of passage at specific barriers identified as inhibiting recovery.

Criteria are established to gauge achievement of recovery objectives and assess whether actions have resulted in the recovery of bull trout. Recovery criteria reflect the stated objectives and consideration of population and habitat characteristics within the recovery unit. The current status of bull trout was evaluated based on four population elements. The four elements were: 1) number of local populations, 2) adult abundance (defined as the number of spawning fish present in a core area in a given year), 3) productivity, or the reproductive rate of the population (as measured by population trend and variability), and 4) connectivity (as represented by the migratory life history form and functional habitat). For each element, bull trout were classified based on relative risk categories.

These elements were derived from the best scientific information available concerning bull trout population and habitat requirements (Rieman and McIntyre 1993; Rieman and Allendorf 2001) (see also Appendix 4, Effective Population Size). Levels of adult abundance and the number of local populations needed to spread extinction risk should be viewed as a best estimate given limited information on bull trout. Based on the best data available and professional judgment, recovery unit teams then evaluated each element under a potential recovered condition. Evaluation of these elements under a recovered condition assumed that actions identified within this chapter had been implemented. This approach acknowledges that, even when recovered, the status of bull trout populations in some core areas may remain short of ideals described by conservation biology theory. Some core areas under recovered conditions may be limited by natural attributes or patch size, and may always remain at a relatively high risk of extirpation.

Number of Local Populations

Multiple local populations distributed and interconnected throughout a watershed provide a mechanism for spreading risk from stochastic events. Distribution of local populations in such a manner is, in part, an indicator of a functioning core area. Based in part on guidance from Rieman and McIntyre (1993), bull trout core areas with fewer than five local populations are at increased risk; core

areas with between 5 to 10 local populations are at intermediate risk; and core areas which have more than 10 interconnected local populations are at diminished risk.

Some recovery units also use the term "potential" local populations in the number of local populations or distribution criteria. A potential local population is defined as a local population that does not currently exist, but which might exist and contribute to recovery in a known or suspected unoccupied area, if spawning and rearing habitat or connectivity is restored in that area.

Adult Abundance

Recovered abundance levels were evaluated by considering theoretical estimates of effective population size, historic census information, and the professional judgment of recovery unit team members. In general, effective population size is a theoretical concept that allows prediction of potential future losses of genetic variation within a population, due to small population sizes and genetic drift. For the purposes of bull trout recovery planning, abundance levels were conservatively evaluated at the local population and core area levels. Local populations that contained fewer than 100 spawning adults per year were classified at risk from inbreeding depression. Bull trout core areas that contained fewer than 1,000 spawning adults per year were classified as at risk from genetic drift.

Productivity

A stable or increasing population is a key criterion for recovery under the requirements of the Endangered Species Act. Measures of the trend of a population (the tendency to increase, decrease, or remain stable) include population growth rate or productivity. Estimates of population growth rate (*i.e.*, productivity over the entire life cycle) that indicate a population is consistently failing to replace itself, indicate increased extinction risk. Therefore, the reproductive rate should indicate the population is replacing itself, or growing.

Since estimates of the total population size are rarely available, the productivity or population growth rate is usually estimated from temporal trends in indices of abundance at a particular life stage. For example, redd counts are often used as an index of a spawning adult population. The direction and magnitude of a trend in the index can be used as a surrogate for the growth rate of the entire population. For instance, a downward trend in an abundance indicator may signal the need for increased protection, regardless of the actual size of the population.

The population growth rate is also an indicator of extinction probability. The probability of going extinct cannot be measured directly; it can, however, be

estimated as the consequence of the population growth rate and the variability in that rate. For a population to be considered viable, its natural productivity should be sufficient to replace itself from generation to generation. Evaluations of population status will also have to take into account uncertainty in estimates of population growth rate or productivity. The growth rate must indicate a stable or increasing population for a period of time for the population to contribute to recovery.

Connectivity

The presence of the migratory life history form of bull trout was used as an indicator of the functional connectivity of the system. If the migratory life form was absent from a core area, or if the migratory form is present but local populations lack connectivity, the core area was considered to be at increased risk. If the migratory life form persists in at least some local populations, with partial ability to connect with other local populations, the core area was judged to be at intermediate risk. Finally, if the migratory life form was present in all, or nearly all, local populations, and had the ability to connect with other local populations, the core area was considered to be at diminished risk.

Distinct Population Segment Structure and Population Units

Population units of bull trout exist in which all fish share an evolutionary legacy and which are significant from an evolutionary perspective (Spruell *et al.* 1999). These population units can range from a local population to multiple recovery units and theoretically should represent a distinct population segment. Although such population units are difficult to characterize, genetic data have provided useful information on bull trout population structure. For example, genetic differences between the Klamath and Columbia river populations of bull trout were revealed in 1993 (Leary *et al.* 1993). Based largely on this 1993 information and the lack of additional information, the current distinct population segment structure of bull trout in the Klamath and Columbia rivers, Jarbidge River, St. Mary-Belly rivers and Coastal-Puget Sound was developed for the listings in 1998 and 1999.

Since the 1998 listing, genetic analyses have suggested that bull trout populations may be organized on a finer scale than previously thought. Additional genetic data has revealed genetic differences between coastal populations of bull trout, including the lower Columbia and Fraser rivers, and inland populations in the upper Columbia and Fraser river drainages, east of the Cascade and Coast mountains (Williams *et al.* 1997; Taylor *et al.* 1999). There is also an apparent genetic differentiation between inland populations within the Columbia River basin. This differentiation occurs between the (a) mid-Columbia (John Day, Umatilla) River and lower Snake River (Walla Walla, Clearwater, Grande Ronde, Imnaha rivers, etc)

populations and the (b) upper Columbia River (Methow, Clark Fork, Flathead River, etc.) and upper Snake River (Boise River, Malheur River, Jarbidge River, etc.) populations (Spruell *et al.* 2000; Paul Spruell, University of Montana, pers. comm. 2002). Genetic data indicate bull trout inhabiting the Deschutes River drainage of Oregon are derived from coastal populations and not from inland populations in the Columbia River basin (Leary *et al.* 1993; Williams *et al.* 1997; Spruell and Allendorf 1997; Taylor *et al.* 1999; Spruell *et al.* 2000). In general, evidence since the time of listing suggests a need to further evaluate the distinct population segment structure of bull trout populations being considered in this recovery plan. (See further discussion in Bull Trout Recovery and Delisting.)

The Role of Recovery Units in Survival and Recovery of Bull Trout

Recovery units were designated to facilitate development of the recovery plan by placing the scope of bull trout recovery on smaller spatial scales than the larger distinct population segments. Focusing recovery on smaller areas is advantageous because bull trout are widely distributed, and their habitats and factors affecting them vary greatly throughout their distribution. Thus, a narrower scope allows recovery tasks to be tailored to specific areas and encourages implementation of tasks by local interests. Although biological and non-biological issues (*i.e.*, jurisdictional and logistical concerns) were considered in identifying the 27 recovery units, recovery units generally have a biological basis in that they are groupings of bull trout for with historical or current gene flow. Thus, isolated basins, major river basins, and collections of basins represent the boundaries of recovery units

Individual recovery units are important to bull trout recovery by providing for the distribution of bull trout across their native range and maintaining adaptive ability to ensure long-term persistence. Similarly, individual core areas are the foundation of recovery units, and maintenance of these areas is critical to recovery. Genetic diversity enhances long-term survival of a species by increasing the likelihood that the species is able to survive changing environmental conditions. For instance, a local population of bull trout may contain individuals with genes that enhance their ability to survive in the prevailing local environmental conditions. Individuals with a different genetic complement may persist in the local population in much lower abundance than those with locally adapted genes.

Each recovery unit is important; and recovery units are an appropriate scale at which to gauge progress toward recovery for individual distinct population segments and the species within the coterminous United States. Recovering bull trout in each recovery unit will maintain the overall distribution of bull trout in their native range. Conserving core areas and their habitats within recovery units should preserve genotypic and phenotypic diversity and allow bull trout access to diverse

habitats. The continued survival and recovery of individual core areas is critical to the persistence of recovery units and their role in the recovery of a distinct population segment. Recovered conditions and tasks for core areas are described in recovery unit chapters.

The Role of Artificial Propagation and Transplantation in Bull Trout Recovery

Section 3(3) of the Endangered Species Act lists artificial propagation and transplantation as methods that may be used for the conservation of listed species. Hatcheries have played an important role in recovery efforts of other listed fish species (Rinne *et al.* 1986). The bull trout recovery plan recognizes that certain recovery units within the distinct population segment may require the use of artificial propagation techniques in order to meet recovery criteria. Artificial propagation could involve the transfer of bull trout into unoccupied habitats or could involve the use of Federal, State, or Tribal hatcheries to assist in recovery efforts (Buchanan *et al.* 1997; USFWS 1998e). The use of artificial propagation programs for bull trout must be authorized by the U.S. Fish and Wildlife Service and meet applicable State and Tribal fish-handling and disease policies.

The Montana Bull Trout Scientific Group evaluated seven strategies for the potential use of artificial propagation in the recovery of bull trout (MBTSG 1996g). The report evaluated the use of hatcheries in establishing genetic reserves, restoration stocking, research activities, supplementation programs, introductions to expand distribution, and the establishment of "put, grow, and take" fisheries. The report concluded that the potential use of hatcheries in bull trout recovery could include the establishment of genetic reserves for declining populations, restoration stocking, and some research activities including the evaluation of hybridization. However, the report concluded that the use of hatcheries for bull trout supplementation programs, "put, grow, and take" stocking, and introductions outside historic range were not appropriate. The bull trout recovery plan recommends that a study be initiated to determine the effectiveness and feasibility of using artificial propagation in bull trout recovery. Specific goals and objectives for the use of hatcheries in the recovery and conservation of bull trout should be identified. Information gained from this study will help guide proposed artificial propagation programs identified in individual recovery unit chapters.

Any artificial propagation program instituted for bull trout will follow the joint policy of the U.S. Fish and Wildlife Service and the National Marine Fisheries Service regarding controlled propagation of listed species (65 FR 56916). The overall guidance of the policy is that every effort should be made to recover a species in the wild before implementing an artificial propagation program. Because recovery for bull trout entails the identification and correction of threats affecting

bull trout, artificial propagation programs should not be implemented until the reasons for decline have been addressed.

The Role of Fire and Aquatic Habitats in Bull Trout Recovery

Bull trout evolved under historic fire regimes, in which disturbance to streams from forest fires resulted in a mosaic of diverse habitats. However, forest management and fire suppression over the past century have increased homogeneity of terrestrial and aquatic habitats, increasing the likelihood of large, intense forest fires in some areas. Because the most severe effects of fire on native fish populations can be expected where populations have become fragmented by human activities or natural events, an effective strategy to ensure persistence of native fishes against the effects of large fires may be to restore aquatic habitat structure and life history complexity of populations in areas susceptible to large fires (Gresswell 1999).

Rieman and Clayton (1997) discussed relations among the effects of fire and timber harvest, aquatic habitats, and sensitive species. They noted that spatial diversity and complexity of aquatic habitats strongly influence the effects of large disturbances on salmonids. For example, Rieman, Lee, Chandler, and Myers (1997a) studied bull trout and redband trout responses to large, intense fires that burned three watersheds in the Boise National Forest in Idaho. Although the fires were the most intense on record, there was a mix of severely-to-unburned areas left after the fires. Fish were apparently eliminated in some stream reaches, whereas others contained relatively high densities of fish. Within a few years after the fires and after areas within the watersheds experienced debris flows, fish had become reestablished in many reaches, and densities increased. In some instances, fish densities were higher than those present before the fires or in streams that were not burned (Rieman, Lee, Chandler, and Myers 1997). These responses were attributed to spatial habitat diversity that supplied refuge areas for fish during the fires, and the ability of bull trout and redband trout to move among stream reaches. For bull trout, the presence of migratory fish within the system was also important (Rieman and Clayton 1997; Rieman, Lee, Chandler, and Myers 1997).

For bull trout recovery, the appropriate strategy to reduce the risk of fires on bull trout habitats is to emphasize the restoration of watershed processes that create and maintain habitat diversity, provide access to habitats, and protect or restore migratory life-history forms of bull trout. Both passive (*e.g.*, encouraging natural riparian vegetation and floodplain processes to function appropriately) and active (*e.g.*, reducing road density, removing barriers to fish movement, and improving habitat complexity) recovery actions offer the best approaches to protect bull trout from the effects of large fires.

The Role of the Mainstem Columbia and Snake Rivers

Historically, the mainstem Snake and Columbia rivers were likely used as migration corridors, foraging areas, and overwintering habitat by fluvial bull trout that originated in tributary streams throughout the basins. Presently, mainstem habitat may or may not be used by bull trout depending on the strength of their populations in tributary streams and the availability of migration corridors that connect to the Columbia and Snake rivers.

Bull trout have multiple life history strategies, including migratory forms, throughout their range (Rieman and McIntyre 1993). Migratory forms appear to develop when habitat conditions allow movement between spawning and rearing streams and larger rivers or lakes where foraging opportunities may be enhanced (Frissell 1993). For example, multiple life history forms (*e.g.*, resident and fluvial) and multiple migration patterns have been noted in the Grande Ronde River (Baxter 2002). Parts of this river system have retained habitat conditions that allow free movement between spawning and rearing areas and the mainstem Snake River. Such multiple life history strategies help to maintain the stability and persistence of bull trout populations to environmental changes. Benefits to migratory bull trout include greater growth in the more productive waters of larger streams and lakes, greater fecundity resulting in increased reproductive potential, and dispersing the population across space and time so that spawning streams may be recolonized should local populations suffer a catastrophic loss (Rieman and McIntyre 1993; MBTSG 1998; Frissell 1999;).

In the mid-Columbia River, bull trout have been observed passing the fish ladders at Wells, Rocky Reach, and Rock Island dams. Bull trout have also been observed in the fish ladder counting stations at Bonneville Dam in the lower Columbia River (Sprague, *in litt.* 2002). In the Snake River, bull trout have been observed in the fish ladder counting stations at Little Goose and Lower Monumental dams (Richards 2002) and at the juvenile fish collection facilities at Lower Granite, Little Goose, Lower Monumental, and Ice Harbor dams (Baxter 2002).

Bull trout use of the mainstem Columbia River has recently been documented by radio-tagging studies conducted by the U.S. Fish and Wildlife Service (Kelly-Ringel and DeLaVergne 2000, 2001) and the Chelan, Douglas, and Grant County public utility districts (Kreiter 2001, 2002). This information indicates that bull trout are likely foraging and/or overwintering throughout the mainstem Columbia River (Kreiter 2002; T. Dresser, Grant County Public Utilities District, pers. comm. 2002; D.Ward, ODFW, pers. comm., 2002; Oregon Department of Fish and Wildlife *in litt.* 2001; J. Wachtel, WFW, *in litt.* 2000).

Studies by the Oregon Department of Fish and Wildlife (Hemmingsen *et al.* 2001a, b) and Idaho Power Company (Chandler and Richter 2001) have verified movements of bull trout between tributary streams and the mainstem Snake River (Buchanan *et al.* 1997; J. Chandler, IPC, pers. comm. 2002.

Radio-tag studies have also shown evidence of bull trout movement between Pine and Indian creeks as well. One fish that was radio-tagged in Indian Creek was found to have moved to a tributary of the North Fork of Pine Creek (Chandler and Richter 2001). Chandler and Richter (2001) also reported that two bull trout that were radio-tagged in the reservoir moved into the Pine Creek system. One fish was tracked as far as the confluence of Lake Creek and North Pine Creek and then moved back to the reservoir. The other fish moved about 4.97 miles (8 kilometers) into Pine Creek before being lost to predation.

Restoring and maintaining connectivity between existing populations of bull trout is important for the persistence of the species (Rieman and McIntyre 1993), as well as providing for expression of the migratory life history form. Migration and occasional spawning between populations increases genetic variability and strengthens population variability (Rieman and McIntyre 1993).

In summary, foraging and migratory habitat are important to bull trout. Although currently fragmented by the presence of dams, the mainstem Columbia and Snake rivers provide habitat that potentially helps to maintain interactions between populations of bull trout in the tributaries, and provides for foraging and overwintering opportunities. Migratory corridors such as these allow individuals access to unoccupied but suitable habitats, foraging areas, and refuges from disturbances (Saunders *et al.* 1991). In the absence of the migratory bull trout life form, isolated populations cannot be replenished when disturbance makes local habitats temporarily unsuitable, the range of the species is diminished, and the potential for enhanced reproductive capabilities are lost (Rieman and McIntyre 1993). The relationship of the mainstem Snake and Columbia rivers to individual recovery units and the local populations within those units are discussed in the respective recovery unit chapters.

Recovery Monitoring and Evaluation

A key component of recovery planning is an effective monitoring and evaluation program. Monitoring involves systematic observation, detection, and recording of conditions, resources, and environmental effects of management programs and actions. It allows determination of trends in fish populations and how well the elements of the strategy are working, and enables the testing of key assumptions and resolution of important questions. Specific goals of bull trout monitoring include characterization of the status of recovery units by describing population abundance, trends in abundance, distribution of bull trout within core habitat, and connectivity. Accurate characterization of the status of bull trout populations, before and after implementation of recovery actions, enables estimation of the effectiveness of those actions. A description of work done to date on bull trout monitoring, and proposals for future approaches, is provided in the (Bull Trout Workshop Report *in litt.* 2002)

Monitoring and evaluation efforts can be divided into different categories, depending upon what kinds of questions are being addressed. *Baseline monitoring* is intended to depict the reference conditions in fish population abundance, trend, distribution, and habitat, from which a change that might be due to management activities could be detected. *Implementation monitoring* is aimed at determining whether strategy elements of a management plan are being implemented correctly. *Effectiveness monitoring* addresses the question of whether strategy elements and actions, having been implemented, are achieving their objectives. *Validation monitoring* is designed to explore key assumptions underlying conservation actions and strategies, by ascertaining cause-and-effect relationships.

It may be impractical to monitor the effectiveness of each and every recovery action, or the status of populations in every core area in every recovery unit, to the same extent. The health of populations and the quality of bull trout habitat will need to be inferred from indicators. Potential indicators include both biological and physical measures, which can be divided into five categories: (1) *Fish* – measures of abundance, distribution, genetic diversity, age structure, fecundity, etc., (2) *Physical (instream) habitat* – gravel size, channel morphology, etc., (3) *Water quantity* – minimum flows, seasonal response, etc., (4) *Water quality* – temperature, sediment, etc., and (5) *Land use/cover* – amount of vegetation in stream buffers, percentage of watershed covered by impervious surfaces, etc. Indicators may in some instances be identical to actual characteristics of interest; in other instances, they will be surrogates for key features, intended to provide a reasonable representation of the attribute of interest.

Efficient use of monitoring and recovery resources and effort will require adhering to the principles and procedures of adaptive management. Adaptive management is a science-based management approach, incorporating continuing review of how well actions are achieving their objectives. Adaptive management recognizes uncertainties are unavoidable and that action cannot wait for uncertainties to be eliminated. The approach seeks to find actions that maximize the ability to achieve conservation and recovery objectives, while facilitating learning about key uncertainties relevant to selecting long term management actions. Based on results of monitoring and evaluation efforts, it can help suggest what steps are necessary to increase chances for successful recovery. Over time, a better understanding of what is working and what is not should be gained, which ideally will lead to improvement in the quality and efficacy of management decisions and actions. The course of adaptive management can be encapsulated in a series of steps, which describe one of multiple iterations in the process (that is, after the last step, start again with step #1, incorporating the new data):

1. Identify what is known and unknown in the various recovery units (scientific foundation).

2. Identify strategies/key actions for implementation (conservation actions).

3. Identify the performance standards that need to be measured to determine population status and efficacy of conservation strategies.

4. Identify and prioritize key technical and policy questions related to the scientific foundation and conservation strategies.

5. Determine the most efficient allocation of resources (funding and personnel) to achieve conservation and information objectives, using chosen performance measures.

6. Design (or update) a detailed monitoring plan to meet the identified objectives, consistent with available resources.

7. Implement conservation strategy and monitoring plan.

Planning a regional monitoring program will require coordination and prioritization of diverse efforts by a number of different agencies. This involves several tasks, among them (1) inventorying and evaluating existing monitoring programs, (2) defining the ultimate objectives of bull trout monitoring and

evaluation for all of the involved parties, (3) improving coordination between monitoring programs and responsible agencies, (4) addressing key design elements, such as sampling frame (where/when to measure), what to measure, and how to measure (protocol), and (5) coordinating efforts of recovery monitoring with those of other statutory requirements of the Endangered Species Act (*e.g.*, section 4d rules, section 7 consultations, habitat conservation plans).

To help direct and prioritize future monitoring efforts, and to maximize the amount of information useful to recovery planning garnered from current studies, the U.S. Fish and Wildlife Service will establish a Recovery Monitoring and Evaluation Technical Group. The Monitoring and Evaluation Technical Group will be a multi-agency body chaired by the U.S. Fish and Wildlife Service. Desirable skills of potential members include expertise in field studies, population dynamics, char biology, biometrics, and experimental design. Guidance and oversight will be provided by the U.S. Fish and Wildlife Service's Bull Trout Coordinator and the overall recovery team to the Monitoring and Evaluation Technical Group. General, ongoing objectives and tasks of the Monitoring and Evaluation Technical Group will include: (1) increase utility of current data collection for recovery planning, (2) guide and prioritize future studies, (3) summarize monitoring and evaluation needs of cooperators, (4) foster coordination among monitoring programs, (5) help develop and standardize design elements, and (6) review analytical methods of characterizing population and habitat status.

The advice and guidance of the Monitoring and Evaluation Technical Group will be formalized in reports. The reports may include reviews of specific monitoring proposals, summaries of the monitoring and evaluation needs of cooperators, recommendations of appropriate scale and protocols for various management questions, and critiques of analytical methods for estimating population status and monitoring effectiveness. Certain key products of the Monitoring and Evaluation Technical Group will also be subject to independent scientific review.

Bull Trout Recovery and Delisting Determinations

Achieving recovery objectives and making formal delisting decisions are two separate processes. Recovery occurs when threats to a species, or to a distinct population segment, have been removed, and the species is a secure, self-sustaining component of the ecosystem. The recovery criteria established in a recovery plan describe recovery conditions for a listed species in clear and measurable terms. Delisting is the subsequent regulatory rulemaking process that the U.S. Fish and Wildlife Service uses to remove the recovered species, or distinct population segment, from the list of threatened and endangered species, and therefore removing the protections that apply to listed species. A delisting determination must demonstrate

that the species is no longer threatened or endangered, through an analysis of the five listing factors (destruction of habitat, over-utilization, disease or predation, inadequacy of existing regulatory protections, and other natural and man-made factors) set forth in the Endangered Species Act. A delisting determination can only be made on a "listable entity." Listable entities include species, subspecies, or distinct population segments of any species or vertebrate fish or wildlife that interbreeds when mature. Criteria for applying the definition of distinct population segment are found in the joint U.S. Fish and Wildlife Service and National Marine Fisheries Service "Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act" (61 FR 4722). Currently, the rules that listed the Klamath River, Columbia River, Jarbidge River, Coastal Puget-Sound, and St. Mary-Belly River bull trout as threatened, establish those populations as distinct population segments. Subsets of those populations would have to be shown to meet the definition of distinct population segment before the U.S. Fish and Wildlife Service could propose delisting those populations or groups of populations.

Consideration of interim regulatory relief may be provided for recovery units that meet their recovery criteria prior to recovery criteria being achieved in every unit in the overall distinct population segment through an exemption from take prohibitions for bull trout in that recovery unit through the special rulemaking process under section 4(d) of the Endangered Species Act. In that case, bull trout would remain listed as threatened in that recovery unit, but the prohibitions against take of bull trout would be removed through an exemption applying to that recovery unit.

We expect recovery of bull trout to be a dynamic process occurring over time. The recovery objectives are based on our current knowledge and may be refined as more information becomes available. The recovery team acknowledges that some local populations, and possibly core area populations, may be extirpated even though recovery actions are being implemented. Bull trout populations may be extirpated by naturally occurring events and factors due to human activities influencing populations (*e.g.*, habitat degradation, population fragmentation, and nonnative species introductions). Because recovery unit teams develop specific recovery criteria, they should consider extirpations on a case-by-case basis and forward recommendations to the recovery team. If reestablishment of recently extirpated populations is deemed infeasible or impractical by the recovery unit teams, then recovery criteria for a given recovery unit will be revised to reflect the current condition.

ACTIONS NEEDED TO INITIATE RECOVERY

Recovery for bull trout will entail reducing threats to the long-term persistence of populations and their habitats, ensuring the security of multiple interacting groups of bull trout, and providing habitat conditions and access to them that allow for the expression of various life-history forms. Specific tasks falling within the following seven categories will be necessary to initiate recovery across all recovery units:

- Protect, restore, and maintain suitable habitat conditions for bull trout.
- Prevent and reduce negative effects of nonnative fishes and other nonnative taxa on bull trout.
- Establish fisheries management goals and objectives compatible with bull trout recovery, and implement practices to achieve goals.
- Characterize, conserve, and monitor genetic diversity and gene flow among local populations of bull trout.
- Conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks.
- Use all available conservation programs and regulations to protect and conserve bull trout and bull trout habitats.
- Assess the implementation of bull trout recovery by recovery units, and revise recovery unit plans based on evaluations.

Recovery Measures Narrative

In this chapter and all other chapters of the bull trout recovery plan, the recovery measures narrative consists of a hierarchical listing of actions that follow a standard template. The first-tier entries are identical in all chapters and represent general recovery tasks under which specific (*e.g.*, third-tier) tasks appear when appropriate. Second-tier entries also represent general recovery tasks under which specific tasks appear. Second-tier tasks that do not include specific third-tier actions are most often programmatic activities that are applicable across the species' range and appear in *italicized font*. These tasks are explained more fully in this chapter. Some second-tier tasks may not be sufficiently developed to apply to a particular recovery unit at this time and they appear in *an italicized shaded font (as seen here)*. These tasks are included to preserve consistency

in numbering tasks among recovery unit chapters and intended to assist in generating information during the comment period for the draft recovery plan, a period during which additional tasks may be developed. Third-tier entries are tasks specific to recovery unit chapters. They appear in the implementation schedule that follows the narrative section and are identified by three numerals separated by periods.

The recovery plan should be updated as recovery tasks are accomplished, or revised as environmental conditions change, monitoring results become available, and adaptive management evaluations are conducted. The recovery team should meet annually to review annual monitoring reports and summaries, and make recommendations to the U.S. Fish and Wildlife Service.

1 **Protect, restore, and maintain suitable habitat conditions for bull trout.**

1.1 Maintain or improve water quality in bull trout core areas or potential core habitat.

1.2 Identify barriers or sites of entrainment for bull trout and implement tasks to provide passage and eliminate entrainment.

1.3 Identify impaired stream channel and riparian areas and implement tasks to restore their functions.

1.4 Operate dams to minimize negative effects on bull trout in reservoirs and downstream.

1.5 Identify upland conditions negatively affecting bull trout habitats and implement tasks to restore appropriate functions.

2 **Prevent and reduce negative effects of nonnative fishes and other nonnative taxa on bull trout.**

2.1 Develop, implement, and enforce public and private fish stocking policies to reduce stocking of nonnative fishes that affect bull trout.

Activities should include an evaluation of all fish stocking programs including public and private hatchery practices to minimize the risk of further introductions of nonnative species within the range of the bull trout and increased enforcement of fish policies to reduce the threat of inadvertent introductions from private fish ponds.

2.2 Evaluate enforcement policies for preventing illegal transport and introduction of nonnative fishes.

We encourage agencies to review their existing policies and the enforcement of those policies for illegal transport and introductions of nonnative species to ensure that the policies are effective protection of bull trout. Where these policies do not exist, we encourage development of policies to prevent illegal transport and introduction of nonnative species.

2.3 Provide educational opportunities to the public about ecosystem concerns of introductions of nonnative fishes.

A program should be implemented in each State to provide educational and outreach opportunities to the public about the problems and consequences of unauthorized fish introductions.

2.4 Evaluate biological, economic, and social effects of control of nonnative fishes.

This evaluation should provide recommendations and protocols for experimental removal or suppression of nonnative fishes in those areas where nonnative fishes may be adversely affecting bull trout.

2.5 Develop tasks to reduce negative effects of nonnative taxa on bull trout.

Steps to accomplish this task include conducting complete species composition surveys in targeted streams, evaluation of the level of competition of nonnative species on juvenile and subadult bull trout during the winter and summer months, and evaluation of the level of competition between nonnative species and bull trout prey species.

2.6 Implement control of nonnative fishes where found to be feasible and appropriate.

The abundance and distribution of nonnative game fishes may greatly affect bull trout survival and recruitment in a given year. Monitoring of nonnative fish populations should be implemented in conjunction with monitoring of bull trout populations (see task #5.1). Effectiveness monitoring of any control measures can be incorporated into an overall monitoring program for bull trout. Control measures can include experimental removal of nonnative species and targeted harvest of nonnatives through liberalized harvest regulations.

3 **Establish fisheries management goals and objectives compatible with bull trout recovery, and implement practices to achieve goals.**

3.1 Develop and implement State and Tribal native fish management plans integrating adaptive research.

3.2 Evaluate and prevent overharvest and incidental angling mortality of bull trout.

Bull trout are highly susceptible to angling. Steps should be taken to assess the existing and potential impacts of angling on bull trout populations, implement and monitor compliance with existing protective angling restrictions, and provide information to anglers about bull trout identification and special regulations.

3.3 Evaluate potential effects of nonnative fishes and associated sport fisheries on bull trout recovery and implement tasks to minimize negative effects on bull trout.

Efforts should be made to evaluate the level of predation and competition of bull trout with nonnative sport fish. Research needed include assessing impacts of competition for spawning gravels, effects of competition for prey, and levels of predation on and by nonnative species. Once these negative effects have been established, efforts should focus on measures designed to minimize the effects of predation and competition of nonnative species on bull trout.

3.4 Evaluate effects of existing and proposed sport fishing regulations on bull trout.

This task applies to states with the management authority to regulate sport fishing. The states, in cooperation with the U.S. Fish and Wildlife Service, should evaluate management proposals to allow carefully regulated harvest of bull trout where monitoring of the population status provides a clear record that a harvestable surplus can be maintained and that harvest will benefit, or at least not be detrimental to, recovery goals.

4 **Characterize, conserve, and monitor genetic diversity and gene flow among local populations of bull trout.**

4.1 Incorporate conservation of genetic and phenotypic attributes of bull trout into recovery and management plans.

Genetic analysis samples can be collected throughout the range of bull trout as part of an overall monitoring plan. (See the section on Recovery Monitoring and Evaluation for a more detailed discussion.) Local populations should be managed to maintain long-term viability of bull trout. Agencies and individuals should ensure that management practices and polices allow for the long-term viability of unique characteristics of bull trout local populations.

4.2 Maintain existing opportunities for gene flow among bull trout populations.

Where feasible or appropriate, increase the population size and distribution of existing local populations of bull trout to maintain or restore opportunity for gene flow within or between core areas. Methods to explore include, but are not limited to, removal or reduction of competing species and restoration of degraded habitat.

4.3 Develop genetic management plans and guidelines for appropriate use of transplantation and artificial propagation.

Some chapters call for possible transplantation and artificial propagation in order to meet recovery goals within the 25-year time frame (see the Coeur d'Alene (Chapter 15), Deschutes (Chapter 7), and Snake River Washington (Chapter 24) chapters for examples). It will be necessary to establish genetic reserve protocols and standards for initiating, conducting, and evaluating captive propagation programs. It may also be necessary to artificially propagate bull trout to preserve fish that are likely to be extirpated or to conduct research. Protocols will be needed to standardize the process and prevent detrimental effects on the donor population and captive fish, for determining when transplantation and artificial propagation is necessary, how to conduct these activities, and how to evaluate their effectiveness.

5 **Conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks.**

5.1 Design and implement a standardized monitoring program to assess the effectiveness of recovery efforts affecting bull trout and their habitats.

For a complete discussion of monitoring, see the section in this chapter titled "Recovery Monitoring and Evaluation".

5.2 Conduct research that evaluates relationships among bull trout distribution and abundance, bull trout habitat, and recovery tasks.

The list of research needs below provides a few of the priority research projects that apply across the range of the species. The reader should bare in mind that this list is incomplete and additional research may be proposed in individual recovery units.

1) Evaluation of the effectiveness of habitat restoration techniques in restoring watershed function and bull trout cores and local populations. Land and resource management agencies should coordinate and monitor habitat restoration project with the local U.S. Fish and Wildlife Service Field Office. Habitat restoration techniques include, but are not limited to, enhancement and restoration of riparian corridors (fencing for livestock management, stream bank erosion control, alternative water sources, etc.); instream habitat restoration (large woody debris, pool size and frequency, spawning substrate, etc.); upland/forest restoration (restoration of historic contours, native plant restoration and nonnative plant control, prescribed burns, thinning, replanting, etc.); and erosion control (stream bank contouring, fiber matting, vegetation, livestock control, road maintenance and/or decommission, etc.).

2) Determine the suitability of temperature regimes in currently occupied and potentially restorable bull trout drainages.

3) Assess current and historic effects of upland management on changes to the hydrograph. Activities in upland areas such as logging, road building, and grazing have affected hydrograph regimes in bull trout watersheds. The effects of these activities include changes in the timing and magnitude of peak flows.

4) Delineation of migratory habitat in recovery units and in the mainstem Columbia and Snake Rivers. See also the discussion in Columbia and Snake River Mainstem section.

5) Evaluation of temperature as a limiting factor. For bull trout to reach recovery goals it will be necessary to evaluate the role of seasonally elevated water temperatures as a limiting factor to juvenile bull trout rearing and/or adult migration.

6) Surveys to identify suitable unoccupied habitat for bull trout. These efforts should also include development of a comprehensive list of barriers that may be blocking access to suitable habitat by upstream migrating bull trout.

5.3 Conduct evaluations of the adequacy and effectiveness of current and past best management practices in maintaining or achieving habitat conditions conducive to bull trout recovery.

These evaluations can be conducted in conjunction with the overall monitoring effort discussed in the Recovery Monitoring and Evaluation section of this chapter. Best management practices can include those activities associated with water diversion structures and fish screens and livestock grazing and riparian management.

5.4 Evaluate effects of diseases and parasites on bull trout, and develop and implement strategies to minimize negative effects.

5.5 Develop and conduct research and monitoring studies to improve information concerning the distribution and status of bull trout.

Actions associated with this task can include regular presence/absence surveys for each recovery unit. These surveys will be based on the recommendations from the Recovery Monitoring and Evaluation Technical Team discussed in the Recovery Monitoring and Evaluation section.

5.6 Identify evaluations needed to improve understanding of relationships among genetic characteristics, phenotypic traits, and local populations of bull trout.

In addition to research proposals associated with task 5.2 and monitoring, as discussed in the Recovery Monitoring and Evaluation section, it will be important to fully understand the habitat requirements of resident and migratory bull trout populations. This should include assessing the ability and prevalence of resident bull trout to express migratory behavior and determining the habitat characteristics necessary for the migratory life history strategy. Additional information needed includes the annual abundance of breeding adults in a local population and the total breeding adult population for a recovery unit, the population structure and connectivity, life history characteristics including age at first spawning, incidence, regularity and timing of repeat spawning, and total life span, reproductive success in production of pre-adult offspring, survival rate to breeding adults, and reproductive success in replacement breeding individuals. There should also be an effort to investigate the transitional mechanisms between resident and migratory life history forms and an assessment of the threat due to hybridization with brook trout.

6 **Use all available conservation programs and regulations to protect and conserve bull trout and bull trout habitats.**

6.1 Use partnerships and collaborative processes to protect, maintain, and restore functioning core areas for bull trout.

Efforts can include providing technical assistance to private landowners on management of riparian areas, promoting land use planning and management that discourages the development of floodplains, promoting development of land and water management plans that minimize activities that impact bull trout habitat, inventory and promotion of groundwater inflow to key stream reaches for bull trout, and promoting, and assisting, collaborative efforts with local watershed working groups in developing and accomplishing site-specific protection and restoration activities. A necessary element to the success of any of the recovery actions discussed here will be to secure adequate funding and cooperation among interested and affected parties.

6.2 Use existing Federal authorities to conserve and restore bull trout.

Federal agencies should ensure continued compliance with the provisions of section 7 of the Endangered Species Act. Federal, State and private scientific research must also comply with provision under section 10 and states should continue to implement programs, in cooperation with the U.S.

Fish and Wildlife Service, under section 6. Efforts should be made to identify and develop opportunities for collaboration between the Clean Water Act and total maximum daily load planning and bull trout recovery planning and implementation.

6.3 Enforce existing Federal, State, and Tribal habitat protection standards and regulations and evaluate their effectiveness for bull trout conservation.

All existing regulations that may benefit bull trout should be evaluated and fully implemented. These regulations include State habitat protection laws, forest practices laws, lake protection laws, water quality standards, floodplain protection, and emergency flood repair guidelines.

7 **Assess the implementation of bull trout recovery by recovery units, and revise recovery unit plans based on evaluations.**

7.1 Convene annual meetings of each recovery unit team to review progress on recovery plan implementation.

7.1.1 Generate progress reports on implementation of the bull trout recovery plan in each recovery unit.

Annual reviews are necessary to track progress in implementing the recovery plan. Annual reports can be used to identify successful approaches for implementing recovery tasks and direct where efforts should be placed within recovery units.

7.2 Assess effectiveness of recovery efforts.

7.2.1 Develop and implement a standardized monitoring program to evaluate the effectiveness of recovery efforts (coordinate with recovery task 5.1).

A standardized monitoring program is needed to evaluate achievement of recovery objectives and provide information to adaptively manage and improve recovery efforts. See discussion in Recovery Monitoring and Evaluation.

7.3 Revise scope of recovery as suggested by new information.